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Studies on the Rocky Mountain flora—XXVII

PER AXEL RYDBERG

SALICACEAE

POPULUS HASTATA Dode, Extr. Mon. Gen. Populus (Mém. Soc. Hist. Nat. Autun **18**:) 64. 1905

Some years ago we were forced to admit one of Dode's species, *P. Sargentii*. I say forced, because Dode's paper is presented in such an unscientific way that any one might feel inclined to ignore it altogether. His differentiations are based wholly on the leaf forms, and in very few genera do the leaves show so great variation as in *Populus*. In working over Mr. Butler's collection of Montana plants I found numerous specimens of a poplar which has usually been regarded as *P. balsamifera* L., sometimes as *P. trichocarpa* T. & G. A study of the fruit shows that this poplar has the sessile and 3-carpellary fruit and the large involucral cup of *P. trichocarpa*, but the capsule is proportionally longer than in that species and perfectly glabrous. The eastern *P. balsamifera* has evident pedicels and almost always 2-carpellary ovary and much smaller involucral cup. The leaves are usually broader than in *P. balsamifera* and often subcordate at the base. They resemble much those of *P. candicans* Ait. in outline but are perfectly glabrous. *P. candicans* has also pediceled and 2-carpellary capsules. It is apparent that this species represented by Butler's material is *P. hastata* of Dode, for he associated it with *P. trichocarpa* and pointed out just the characters by which it differs from that species. The name *hastata* was given in reference to the

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form of the young leaves, which he described as being hastate. His idea of the term hastate must have been rather strange, for he figured the different leaf forms, and the form of leaf illustrated as representing the young shoots is elongate-ovate with slightly cordate base.

It is represented in the herbarium of the New York Botanical Garden by the following specimens:

ALBERTA: Bow River, May 26, 1899, *McCalla 2236.*

MONTANA: Flathead Lake, July 23, 1900, *J. W. Blankinship;* Columbia Falls, September 14, 1892, *R. S. Williams* (both determined as *P. balsamifera candicans*); various localities in Montana, *Butler 124, 125, 126, 127, 128, 137.* To this may also belong the following, which are in leaf only: *Butler 112, 113, 114, 135, 147.*

IDAHO: Salubria, July 10, 1899, *M. E. Jones 6541* (labeled *P. trichocarpa*).

POPULUS BESSEYANA Dode, loc. cit. 38

Another poplar collected by Butler seems to be impossible to identify with any of the accepted species. Butler's material is all in leaf only, but there is in our collection one specimen collected by Miss Isabel Mulford, in Idaho, which evidently belongs here, and this specimen is in fruit. It is evidently related to *P. deltoides* Marsh., but the leaf shape is different and the pedicels are very short, shorter than the capsule. The young stems are perfectly terete, not at all angled; the bases of the leaves of the mature branches are rounded or subcuneate at the base and more or less serrate along the base; the basal glands are small and the petioles flattened. In *P. Sargentii* Dode the leaves are flabellate-cordate, with an open concave sinus at the base, which is toothless. The leaves resemble much *P. acuminata* Rydberg but are broader and less cuneate at the base, and in the latter species the petioles are terete. I adopt Dode's name, not because I can definitely identify it by his diagnosis but because his illustrations of the leaves resemble those of this species.

To this belong the following specimens:

IDAHO: Fish Haven, August 8, 1898, *Isabel Mulford 263.*

MONTANA: Delta of Flathead River, Big Forks, Montana, August 14, 1901, *Umbach 192;* and from several localities, *Butler 109, 111, 115, 116, 117, 120, 136, 139, 140, 144, 145, 149, 153.*

POPULUS FREMONTII Torr.

The known range of this species was extended last summer, when it was collected by Professor A. O. Garrett and the writer in and around the town of Moab, southeastern Utah; and specimens evidently also belonging to it were seen in the Cottonwood and White canyons about 100 miles farther southwest.

Willow hybrids are not uncommon in Europe and rather common in cultivation; but we find very rarely any references to any spontaneous hybrids of American species mentioned. It will therefore not be out of place to record the following specimens probably representing hybrids, although no definite proof can be given of their origin.

Salix cordata × S. monticola

The shrubs referred here have capsules shorter than in *S. cordata* Muhl. but longer than in *S. monticola* Bebb; the habit and the bark are those of the latter; but the narrow leaves (although less serrate) and the bractlets are those of *S. cordata angustata* (Pursh) Anders., the form of *S. cordata* common in the Rockies. The capsules of the specimens seen usually remained undeveloped. The staminate catkins resemble most those of *S. monticola*. *S. monticola* was growing mixed in with the supposed hybrid. *S. cordata angustata* is also growing in the Big Cotton Canyon, although no specimens of it were noticed in the immediate vicinity where the plants were collected.

UTAH: Big Cottonwood Canyon, below Silver Lake, July 11, 1905, *Rydberg 6877, 6878,* and *6883;* July 4, 1905, *Rydberg & Carlton 6615.*

Salix glaucops × S. monticola

The specimens resemble *S. glaucops* Anders. in the capsules and bractlets, but the former are less densely hairy; the leaves are more like those of *S. monticola,* being finely serrate, glabrate in age and glaucous beneath; the young branches are somewhat villous. Both *S. monticola* and *S. glaucops* are growing in the Big Cottonwood Canyon.

UTAH: Big Cottonwood Canyon, Salt Lake City County, August 23, 1905, *A. O. Garrett 1671.*

Salix Sandbergii sp. nov.

Bark of the branches reddish chestnut brown, finely puberulent when young; leaves oval or elliptic, 2–4 cm. long, densely white-silky on both sides, grayish above, silvery beneath, entire or nearly so; pistillate aments sessile, naked, about 4 cm. long; bractlets purple, obovate-spatulate, 3 mm. long, white-pilose; capsule glabrous, 4–5 mm. long; stipe about 1.5 mm. long; style about 0.5 mm. long; lobes of stigma short.

The type was distributed as *Salix lasiolepis* Benth., to which it is not at all closely related. The leaves resemble somewhat those of *S. sitchensis* Sanson and *S. bella* Piper, but the capsule is glabrous and the plant belongs to the *S. cordata* group. On account of the white leaves it would be placed next to *S. Hookeriana* Barrett, but the leaves are silky, not villous, and entire, and the aments and capsules are much smaller. It grows on banks of streams.

IDAHO: Valley of Hatwai Creek, April 28, 1892, *Sandberg, MacDougal & Heller 71* (type, in herb. N. Y. Bot. Garden).

The following species of willows are here recorded for the Rocky Mountain region: *Salix erythrocoma* Barrett (*S. arguta erythrocoma* Anderson), *S. lucida* Muhl., *S. Hookeriana* Barrett, *S. conjuncta* Bebb, *S. MacCalliana* Rowley, *S. alexensis* (Anders.) Coville, *S. Barrettiana* Hook., *S. Seemanii* Rydb., *S. Drummondiana* Barrett, *S. arbusculoides* Anders., *S. desertorum* Richards., *S. saskatchewana* Seem., and *S. Fernaldii* Blankinship, from the Canadian Rockies south of the 55° parallel; and *S. conjuncta* Bebb and *S. Fernaldii* Blankinship also from Montana.

ULMACEAE

Celtis rugosa sp. nov.

A tree, 5–10 m. high, with rounded crown; bark gray, corky; twigs brownish, pubescent when young; petioles 6–10 mm. long; leaf blades broadly ovate, oblique, 4–7 cm. long, somewhat cordate at the base, short-acuminate, sharply serrate except at the base and at the apex, coriaceous, dark green, very shiny and slightly scabrous above, brownish or yellowish green, dull, puberulent beneath, strongly reticulate and rugose; pedicels 15–25 mm. long; fruit globose, about 8 mm. in diameter, brownish; style short but evident.

This species is related to *C. reticulata* Torr. but differs in its

longer pedicels (in *C. reticulata* 1 cm. long or less) and in its serrate, short-acuminate leaves, which are less pubescent, more shiny, and much less rough above. It grows in gulches and mountain valleys of Colorado.

COLORADO: Golden, Aug. 29, 1895, *P. A. Rydberg* (herb. N. Y. Bot. Garden); Aug. 30, 1895, *C. L. Shear 3263;* gulch west of Pennock's mountain ranch, May 26, 1897, *C. S. Crandall 2254.*

Celtis occidentalis L. is included in the Rocky Mountain flora by Coulter & Nelson,* but erroneously so, the writer thinks. *Celtis Douglasii* Planchon, *C. rugosa*, and perhaps also *C. reticulata* Torr. have been mistaken for it.

URTICACEAE

Urtica strigosissima sp. nov.

Perennial, dioecious; stem 1 m. high or more, glabrous below, strongly retrorsely strigulose above, but almost without bristles; stipules narrowly linear-lanceolate, acuminate; petioles 2–3 cm. long; leaf blades lanceolate, 3–5-ribbed, sharply serrate, rounded or acute at the base, long-acuminate at the apex, 5–10 cm. long, 1.5–5 cm. wide, finely strigulose beneath; flower clusters slender, the upper almost equalling the leaves; sepals ovate, about equalling the achenes.

This species resembles *U. gracilis* Ait. in habit and leaf form, but is more strigose and rarely at all bristly. In pubescence it resembles *U. Breweri* S. Wats. but has narrower leaves and narrowly linear-lanceolate, acuminate, instead of oblong and obtuse, stipules. It grows on river banks at an altitude of 1,000–2,500 m.

IDAHO: Forest, Nez Perces County, July 29, 1896, *A. A. & E. Gertrude Heller 3475* (herb. Columbia University).

Urtica viridis sp. nov.

Perennial with a horizontal rootstock, dioecious; stem 1–1.5 m. high, slender, glabrous or sparingly bristly, round-angled; stipules linear-lanceolate, acuminate, 5–8 mm. long; petioles short, one fifth to one third as long as the leaf blades; these from narrowly lanceolate to ovate, coarsely toothed, 4–10 cm. long, thin, light green, almost glabrous; panicles many-flowered, often equalling the upper leaves: sepals oval or ovate, usually half longer than the achenes.

* New Man. Bot. Cent. Rocky Mts. 143.

This species is closely related to *U. cardiophylla* Rydb. but differs in its narrower leaf blades, shorter petioles, longer and denser inflorescence, and longer sepals. In habit it closely resembles *U. gracilis* but differs in its practically glabrous stem and thinner and more glabrous leaves.

MONTANA: Emigrant Gulch, Aug. 23, 1897, *Rydberg & Bessey 3935* (type, in herb. N. Y. Bot. Garden); Jack Creek Canyon, July 15, 1897, *3936;* Jocko Creek, June 10, 1901, *D. T. MacDougal 275;* Melrose, July 6, 1895, *P. A. Rydberg 2612;* Lima, Aug. 6, 1895, *Rydberg 2613*.

WYOMING: Halleck Canyon, July 4, 1900, *Aven Nelson 7444*.

IDAHO: Priest Lake, July 28, 1900, *D. T. MacDougal 235;* Cooper's Warm Springs, July 1892, *Isabel Mulford*.

ALBERTA: Rocky Mountains, 1858, *E. Bourgeau*.

Parietaria occidentalis sp. nov.

Annual; stem slender, erect, simple or branched at the base, long-villous, 1–4 dm. high; leaf blades thin, light green, lanceolate, acute at the base, obtuse at the apex, 1–4 cm. long, 5–18 mm. wide, sparingly pubescent; bracts of the involucre linear, obtuse; sepals oblong or lance-oblong, obtuse or acutish.

This species is related to *P. pennsylvanica* Muhl. but differs in the long hairs of its stem, light green color, and the more obtusish sepals. It grows in moist shaded places.

IDAHO: Clearwater River, Nez Perces County, May 14, 1892, *Sandberg, MacDougal & Heller 176* (type, in herb. N. Y. Bot. Garden).

WASHINGTON: Wawawai, May 1897, *Elmer 755;* Alamota, June 1893, *Piper 1507*.

NEVADA: East Humboldt Mountains, August 1868, *S. Watson 1084*.

POLYGONACEAE

Eriogonum biumbellatum sp. nov.

Suffruticose perennial, branched at the base; leaves basal, clustered at the ends of the short branches, 2–5 cm. long, short-petioled; blades oblanceolate, finely tomentose on both sides when young, soon glabrate and green on both sides; scapes 2–3 dm. high, sparingly tomentose; involucres in compound umbels; bracts verticillate, similar to the leaves but smaller; involucres with a

turbinate tube, which is about 2 mm. long, slightly tomentose; its lobes oblong, 1.5–2 mm. long, obtuse; perianth yellow, glabrous, 3–4 mm. long, with a stipelike base; divisions elliptic, obtuse, the outer slightly longer than the inner; filaments ciliate; ovary more or less hairy above, 3-angled.

This species is related to *E. umbellatum* Torr., *E. neglectum* Greene (*E. umbelliferum* Small), and *E. croceum* Small. It has the compound inflorescence of the last one, but the leaves are green and glabrate in age and much narrower than in the other species mentioned.

UTAH: Fish Lake around Twin Creeks, August 8, 1905, *Rydberg & Carlton 7376, 7409,* and *7483;* Fish Creek Canyon, August 2, 1909, *A. O. Garrett 2568.*

Eriogonum idahoense sp. nov.

Shrub 4–6 dm. high with gray bark; branches more or less tomentose, erect; leaves 2–3 cm. long, short-petioled; blades oblanceolate, white-tomentose beneath, loosely floccose and soon glabrate above; floral branches about 1 dm. high; inflorescence a compound trichotomous flat-topped cyme; involucres in the axils peduncled; peduncles of the lower forks 1 cm. long; branches of the cymes short, not over 5 cm. long; involucres turbinate, about 3 mm. long, floccose; lobes about 1 mm. long, lanceolate-oblong, obtuse; perianth yellow, glabrous, about 2 mm. long, without stipelike base; fruit unknown.

The type was labeled *Eriogonum microthecum* Nutt., which it resembles in habit, but the flowers are yellow instead of pink or white, and the lobes of the involucres are longer and not scarious-margined. It is more closely related to *E. orendense* A. Nels. and *E. campanulatum* Nutt. From the first it is distinguished by the leaves, which are glabrate above, the tall stem, and the more open inflorescence; from *E. campanulatum* by the tall shrubby habit and the tomentose involucre.

IDAHO: Wieser, July 7, 1899, *M. E. Jones 6511* (type, in herb. N. Y. Bot. Garden).

Eriogonum spathuliforme sp. nov.

Perennial, shrubby at the base, leaves all near the base; petioles 1–2 cm. long; blades elliptic to spatulate, 1–3.5 cm. long, white-tomentose on both sides, densely so beneath; stem scapiform,

2–3 dm. high, trichotomously branched, with ascending branches; bracts triangular, 5 mm. long or less; involucres in the lower forks short-peduncled, the rest sessile, glabrous, turbinate, 3 mm. long; lobes rounded, scarious-margined; perianth white, glabrous, 2–2.5 mm. long, campanulate; divisions equal, obovate; filaments slightly hairy below; ovary glabrous.

In habit and leaf form this species resembles *E. spathulatum* A. Gray, but the involucres are glabrous instead of tomentose, and the lower ones are peduncled; the stem is also perfectly glabrous. It differs from *E. tristichum* Small and *E. salicinum* Greene in its broader leaves and the scarious-margined lobes of the involucre. Jones' specimens are smaller and more cespitose than the type.

UTAH: Sandy washes near Belknap, June 12, 1900, *Stokes* (type, in herb. N. Y. Bot. Garden); Marysvale, August 30, 1894, *M. E. Jones 5969* (?).

Eriogonum depressum (Blankinship) Rydb. comb. nov.

Eriogonum ovalifolium depressum Blankinship, Mont. Agr. Coll. Sci. Stud. Bot. **1**: 49. 1905.

Eriogonum rubidum frigidum Gand. Bull. Soc. Bot. Belg. **42**: 194. 1906.

Dr. J. K. Small has for some years regarded this as a distinct species, and it is found in the herbarium of the New York Botanical Garden under a manuscript name of his, which, however, was never published.

Eriogonum ramosissimum Eastwood is related to *E. Wrightii* Torr. and does not belong to the *corymbosum* group, to which it was referred.

Eriogonum crassifolium Benth. is the same as the original *E. flavum* Nutt. What Coulter & Nelson and others have regarded as *E. flavum* should be known as *E. chloranthum* Greene. *E. aureum* Nutt. is the same, but the name was first published as a hyponym, and when finally it was properly published there was already an *E. aureum* Jones.

Torrey and Gray, in their revision of *Eriogonum*, described *E. strictum* Benth. as having subequal sepals, and they have been followed by S. Watson and others. Bentham, in his original description of the species, did not mention whether the perianth

lobes are equal or not, but in his subsequent treatise of the genus in De Candolle's Prodromus he expressly stated that they are unequal. In the only two specimens found in the herbarium of the New York Botanical Garden, in my opinion belonging to *E. strictum*, the outer perianth lobes are very broadly oval while the inner are oblong. The species should therefore be associated with *E. dichotomum* Dougl. and not with *E. racemosum* Nutt. and *E. Wrightii* Torr., differing from the first principally in the glabrous involucres. Both *E. strictum* and *E. dichotomum* have been collected in Idaho.

The genus *Eriogonum* is represented by over one hundred species in the Rocky Mountain region. The following ones are not recorded either by Coulter & Nelson nor in my Flora of Colorado or in my Flora of Montana, but they should be included in the flora: *E. androsaceum* Benth. in Alberta, Montana, and British Columbia; *E. thymoides* Benth., *E. compositum* Dougl., *E. proliferum* Benth., *E. elatum* Dougl., *E. strictum* Benth., *E. spergulinum* A. Gray, and *E. vimineum* Dougl., in Idaho; *E. dichotomum* in Idaho and Montana; *E. micranthum* Nutt., *E. nidularium* Coville, and *E. Baileyi* S. Wats., in Idaho and Utah; *E. Porteri* Small, *E. pulvinatum* Small, *E. longilobum* M. E. Jones, *E. ochrocephalum* S. Wats., *E. villiflorum* A. Gray., *E. Shockleyi* S. Wats., *E. polifolium* Benth., *E. Thompsonae* S. Wats., *E. aureum* M. E. Jones, *E. spathulatum* A. Gray, *E. leptophyllum* Torr., *E. bicolor* M. E. Jones, *E. clavellatum* Small, *E. sulcatum* S. Wats., *E. Mearnsii* Parry, *E. ramosissimum* Eastw., *E. densum* Greene, *E. turbinatum* Small, *E. insigne* S. Wats., *E. deflexum* Torr., *E. nutans* T. & G., *E. Wetherillii* Eastw., *E. Thomasii* Torr., *E. subreniforme* S. Wats., *E. Parryi* A. Gray, *E. Ordii* S. Wats., *E. trichopodum* Torr., *E. angulosum* Benth., and *E. puberulum* S. Wats., in Utah; *E. Hookeri* in Utah and Wyoming; *E. tenellum* Torr. in Colorado; and *E. depauperatum* Small in the Black Hills of South Dakota.

Chorizanthe spathulata Small sp. nov.

A more or less branched annual; stem 5–20 cm. high, erect, strigose-canescent; branches erect, strict; lower leaves petioled, 1.5–3 cm. long; blades broadly spatulate, somewhat fleshy, hirsute-strigose on both sides, rounded and sometimes mucronate at the

apex; stem leaves few, spatulate or oblanceolate, much smaller; bracts linear or linear-oblanceolate, arcuate-recurved, spinulose-tipped; involucre cylindroprismatic, 5 mm. long, angled and grooved, strigose; lobes 6, subulate, recurved, spinulose-tipped, the alternating ones somewhat narrower; perianth about 2 mm. long, lobes ovate; stamens mostly 3 (?); filaments adnate to the lower part of the perianth.

This species is related to *C. brevicornu* Torr., and Torrey and Gray included doubtfully Watson's specimens in that species.* It differs in its broader lower leaves and its strict erect branches.

IDAHO: Big Butte Station, June 23, 1863, *Edward Palmer 230* (type, in herb. Columbia University).

NEVADA: 1875, *J. G. Lemmon;* Big Bend of the Truckee, May 1868, *S. Watson 1044.*

CHENOPODIACEAE

Chenopodium pratericola sp. nov.

Annual; stem 3–6 dm. high, striate and angled, nearly glabrous; leaves petioled; blades oblong, lanceolate, or elliptic, 2–6 cm. long, 4–18 mm. wide, entire or with a short tooth on each side, usually callous-mucronate, green and nearly glabrous above, more or less mealy beneath, usually distinctly 3-nerved at the base; flowers in small clusters forming rather dense spikes or panicles; sepals scarious-margined, green on the back, slightly carinate; seeds easily separating from the pericarp, black, shining, about 1.5 mm. in diameter.

This has been included in *C. leptophyllum* (Moq.) Nutt. by most botanists although sometimes confused with *C. oblongifolium* (S. Wats.) Rydb. on account of its broad leaf blades. It differs from the former in its broader leaves, which are practically glabrous on the upper side, distinctly 3-nerved at the base, and at least the larger ones often toothed on the margins. From the latter it differs in its thin, more glabrate leaves and less dense inflorescence.

KANSAS: Riley County, August 2, 1895, *J. B. Norton 436* (type, in herb. N. Y. Bot. Garden).

NEBRASKA: Middle Loupe River, near Thedford, June 21, 1893, *Rydberg 1386;* Forks of Dismal River, July 11, 1893, *Rydberg 1835;* Kearney County, June 13, 1891, *Rydberg 318.*

MISSOURI: Courtney, June 25, 1896, *Bush 367.*

* See Proc. Am. Acad. **8**: 196. 1870.

IDAHO: Lewiston, June 13, 1896, *Heller 3244.*

NEW MEXICO: Mesilla, June 3, 1897, *Wooton 84.*

WYOMING: Platte River, July 14, 1894, *Aven Nelson 483;* Snake River, 1900, *C. C. Curtis.*

ARIZONA: 1876, *Palmer 448.*

Chenopodium succosum A. Nels. is in my opinion a synonym of *C. rubrum* L., being the common American form thereof, and *C. desiccatum* is probably only a small form of *C. oblongifolium* (S. Wats.) Rydb.

Chenopodium lanceolatum Muhl. and *C. paganum* Reich., the former an eastern plant and the latter a European weed, both often erroneously known as *C. viride* L., have been collected in Colorado. The original *C. viride* L. is the same as *C. opulifolium* Schrad. of Europe, not known as occurring in this country. *C. viride* and *C. opulifolium* were based on the same illustration.

Monolepis spathulata A. Gray has been collected in Idaho.

Atriplex odontophora Rydb. is not a synonym of *A. canescens* (Pursh) James but of *A. aptera* A. Nels. instead.

Atriplex buxifolia sp. nov.

A suffruticose perennial; stem branched near the base, with simple branches, 3–4 dm. high; leaves sessile, elliptic or oval, thick, 1–2 cm. long; pistillate flowers in axillary clusters; fruiting bracts ovate, acute, 4–5 mm. long, toothed on the margins, with thick, often flattened processes on the faces.

This is related to *A. Nuttallii* but distinguished by its short oval or elliptic, often fascicled leaves, its simple wandlike branches and small fruit. It grows on dry plains at an altitude of about 1,200 m.

WYOMING: Dayton, Sheridan County, September 1899, *F. Tweedy 2656* (type, in herb. N. Y. Bot. Garden).

Atriplex tetraptera (Benth.) Rydb. comb. nov.

Obione tetraptera Benth. Bot. Sulph. 48. 1844.

This has usually been regarded as the same as *A. canescens* (Pursh) James but differs in its narrow, linear leaves, only 2–5 mm. wide, in its more strongly reticulate fruit wings, which have a broad sinus at the apex, and in that the free portion of the

bracts is less than half as long as the width of the wing. It differs from *A. occidentalis* Torr. in its narrower and sharply toothed wing.

Atriplex Garretti sp. nov.

A low shrub, with straw-colored branches; leaves short-petioled, oval, 2–3 cm. long, grayish, scurfy on both sides, acute at the base, abruptly acuminate at the apex; flowers in axillary and terminal clusters; bracts about 8 mm. long and about as broad, 4-winged, coarsely toothed and occasionally with a few additional processes, with a broad open sinus at the apex; free portion 1–2 mm. long.

The fruit would associate this species with *A. canescens*, *A. occidentalis*, and *A. tetraptera*, but the leaves are quite different in shape. The plant looks in general habit somewhat like *A. confertifolia*, but the fruiting bracts are altogether different. It grows in arid valleys at an altitude of about 1,200 m.

UTAH: Vicinity of Moab, July 1, 1911, *Rydberg & Garrett 8465* (type, in herb. N. Y. Bot. Garden).

Endolepis phyllostegia (Torr.) Rydb. comb. nov.

Obione phyllostegia Torr. in Wats. Bot. King Exp. 291. 1871.
Atriplex phyllostegia S. Wats. Proc. Am. Acad. [illegible]. 1874.

This species should be transferred from *Atriplex* to *Endolepis*, as sepals are present in the pistillate flowers.

Eurotia subspinosa sp. nov.

A dioecious shrub, 6–10 dm. high; branches ascending or spreading, becoming more or less spinescent, finely grayish stellate-tomentose but without longer hairs; leaves linear or oblong, obtuse, entire, 1–3 cm. long, or the secondary ones only 5 mm. long and comparatively broader, with revolute margins; flower clusters axillary, those of the staminate plant crowded and forming simple leafy spikes; fruiting bracts lanceolate, about 6 mm. long; horns usually about 2 mm. long.

This species is more decidedly shrubby than *E. lanata* (Pursh) Moq. and evidently always dioecious, has ascending or spreading branches, which become spinescent, lacks the long hairs intermixed with the stellate pubescence characteristic of *E. lanata*, and has usually longer horns. In *E. lanata* the branches are erect, and the plant is shrubby only at the base. The predominantly

staminate plant has a few pistillate flowers borne on the lower part of the branches. The predominantly pistillate plant has often a few staminate clusters above but is sometimes wholly pistillate. *E. subspinosa* grows on rocky hills in the desert regions.

UTAH: Rocky summits, St. George, May 15, 1903, *Goodding 810* (type, in herb. N. Y. Bot. Garden); 1874, *C. C. Parry 725;* 1875, *E. Palmer;* April 9, 1880, *M. E. Jones 1642;* Virgin River, 1844, *Fremont 440.*

ARIZONA: Fort Verde, October 11, 1887, *E. A. Mearns 188;* Holbrook, August 10, 1897, *Myrtle Zuck;* Total Wreck Mine, 1903, *Thornber 60;* Rincon Mountains, October 7, 1900, *D. Griffiths 1781.*

NEVADA: Thousand Spring Valley, September 1868, *S. Watson 990* (in part); Muddy Valley, Lincoln County, May 6, 1906, *Kennedy & Goodding.*

CALIFORNIA: Mohave Desert, April 1905, *Mrs. C. DeKalb;* Radsburg, April 14, *A. A. Heller 7705;* Red Hill, west of Bishop, May 14, *A. A. Heller 8253.*

SONORA: Genaga di San Bernardino, 1855, *Schott.*

Dondia calceoliformis (Hook.) Rydb. comb. nov.

Chenopodium calceoliformis Hook. Fl. Bor.-Am. **2**: 126. 1838.

This, I think, deserves specific rank. It is characterized from *D. depressa* (Pursh) Britton and *D. erecta* (S. Wats.) A. Nels. by its broad and short, ovate or ovate-lanceolate bracts over 2 mm. wide.

AMARANTHACEAE

Amaranthus pubescens (Uline & Bray) Rydb. comb. nov.

Amaranthus graecizans pubescens Uline & Bray, Bot. Gaz. **19**: 317. 1894.

This probably deserves specific rank. It has been collected in Colorado.

Amaranthus carneus Greene and *A. californicus* S. Wats. should be added to the region. The former has been collected in Montana, and both in Idaho.

PORTULACACEAE

Limnia utahensis sp. nov.

Annual; stem 2–15 cm. long; basal leaves petioled; blades spatulate to linear, 1–3 cm. long, 2–6 mm. wide; stem leaves connate, forming an oblique, 2-lobed disk, 1–2 cm. broad; inflorescence very short, corymbiform; fruiting sepals ovate, acute, 2–3 mm. long, about equalling the pedicels; seeds about 1.5 mm. in diameter, minutely muricate.

This species resembles in habit *L. depressa* (A. Gray) Rydb. and *L. spathulata* (Dougl.) Heller but differs from the former in the long and narrow blades of the basal leaves and more connate stem leaves, from the latter in the large and broad stem leaves, and from both in the large seeds.

UTAH: St. George, 1877, *Palmer 56* (type, in herb. Columbia University); 1874, *C. C. Parry 23* and *24*.

I have not seen the type of *Montia Viae* A. Nels.,* but from the description and specimens named by Professor Nelson I judge it is the same as *Limnia depressa* (Robinson) Rydb.† published a few months earlier.

Coulter and Nelson report *Calyptridium roseum* S. Wats. from western Wyoming, but I think this must be a mistake.

Professor A. O. Garrett and myself collected *Talinum brachypodum* S. Wats. in southeastern Utah. Miss A. Eastwood has reported it from the same region.

ALSINACEAE

Cerastium thermale sp. nov.

Cerastium arvense fuegianum Hollick & Britton, Bull. Torrey Club **14**: 50. 1887. Not Hook. 1854.

Cerastium fuegianum A. Nels.; Coult. & Nels. New Man. Bot. Rocky Mts. 184. 1899.

Densely cespitose perennial; stems decumbent at the base, 5–10 cm. long, viscid-puberulent; leaves yellowish green, less than 1 cm. long, lanceolate, acute, or the lower oblong or spatulate and often obtuse, coriaceous, with a very thick midrib, finely viscid-puberulent; cymes 1–7-flowered, usually condensed and with short pedicels; sepals 4 mm. long, glandular-puberulent, ovate, scarious-

* Bot. Gaz. **42**: 48. 1906.

† Bull. Torrey Club **33**: 139. 1906.

margined; petals about 5 mm. long; capsule about 6 mm. long, slightly curved near the upper end.

This is *Cerastium arvense fuegianum* Hollick & Britton, but not that of Hooker. It differs from *C. strictum* L., its nearest relative, in the low, depressed stem, yellowish herbage, thicker and smaller leaves, the lower of which are often obtuse, and the smaller more condensed flowers. It grows on geyser formations in the Yellowstone National Park, at an altitude of about 2,000 m.

WYOMING: Lower Geyser Basin, Aug. 4, 1897, *Rydberg & Bessey 4025* (type, in herb. N. Y. Bot. Garden); Aug. 11, 1872, *J. M. Coulter.*

Alsine Palmeri sp. nov.

A cespitose perennial; stems several, spreading, 5 cm. high or less, glabrous; leaves ovate or ovate-lanceolate, 2–5 mm. long, fleshy, acute; cyme 3–7-flowered; bracts lanceolate, green; sepals lanceolate, 2.5–3 mm. long, acute; petals about equalling the sepals.

The type was named *Stellaria borealis* by Dr. Watson but is evidently not closely related to it. *A. Palmeri* has the thick leaves of *A. Edwardsii* (R. Br.) Rydb., but the midribs are not prominent, the flowers smaller, the sepals decidedly acute, and the petals only about equalling the sepals in length.

UTAH: Beaver Valley, 1877, *E. Palmer 54* (type, in herb. Columbia University).

Alsine alpestris (Fries) Rydb. comb. nov.

Stellaria alpestris Fries, Mant. 1: 10. 1832.

Alsine strictiflora Rydb. nom. nov.

Stellaria stricta Richards. Frankl. Jour. ed. 2. App. 15. 1823. Not *Alsine stricta* Wahlenb. 1812.

This is the *Stellaria longipes* of most western reports and of Coulter & Nelson's New Manual. It has a short pod and acute sepals, while the original *Stellaria longipes* Goldie has the pods twice as long as the obtuse sepals. If I am not mistaken the latter is the same as *Stellaria valida* Goodding.

Alsine subvestita (Greene) Rydb. comb. nov.

Stellaris subvestita Greene, Ottawa Nat. 15: 42. 1901.

Arenaria cephaloidea sp. nov.

Somewhat cespitose perennial; stem strict, 2–4 dm. high, glabrous; leaves glabrous, erect, filiform-subulate, 3–10 cm. long; flowers in dense headlike cymes; bracts lanceolate, often 1 cm. long, scarious except the thick midrib, scabrous-ciliolate; sepals similar or somewhat broader, 4–5 mm. long; petals oblong, about half longer than the sepals.

This is related to *A. congesta* Nutt. but differs in its narrower bracts, which are wholly scarious, except the midrib, and scabrous-ciliolate on the margins; also in its larger flowers, stricter stem, and less cespitose base.

WASHINGTON: Spokane, Sept. 10, 1902, *O. Kreager 617* (type, in herb. N. Y. Bot. Garden); Clark Springs, July 17, 1902, *Kreager 100;* Loon Lake, July 20, 1897, *J. B. Winston*; Spokane County, June 27, 1884, *Suksdorf.*

IDAHO: Lake Coeur d'Alene, June and July 1892, *G. B. Aiton;* Little Potlatch River, June 2, 1892, *Sandberg, MacDougal & Heller 478.*

Arenaria lithophila Rydb. comb. nov.

Arenaria subcongesta lithophila Rydb. Mem. N. Y. Bot. Gard. 1: 148. 1900.

This, I think, deserves specific rank. Some of the specimens recorded as *A. subcongesta* (S. Wats.) Rydb. should also be referred to it.

Alsinopsis dawsonensis (Britt.) Rydb. comb. nov.

Arenaria dawsonensis Britt. Bull. N. Y. Bot. Gard. 2: 169. 1901.

This species has been collected in the Black Hills of South Dakota.

Alsinopsis pusilla (S. Wats.) Rydb. comb. nov.

Arenaria pusilla S. Wats. Proc. Am. Acad. 17: 367. 1882.

This species has been collected in Idaho.

Arenaria laxiflora nom. nov.

Arenaria Fendleri diffusa Porter, Syn. Fl. Colo. 13. 1874. Not *A. diffusa* Ell. 1818.

Ammodenia oblongifolia (T. & G.) Rydb. comb. nov.

Arenaria peploides major Hook. Fl. Bor.-Am. 1: 102. 1831.
Honckenya oblongifolia T. & G. Fl. N. Am. 1: 176. 1838.
Arenaria sitchensis Dietr. Syn. Pl. 2: 1565. 1840.

B. T. Butler has collected in Montana what seems to be *Arenaria laricifolia* L. At least it is the same plant as the one collected by Turner on the Porcupine River, Alaska, on the strength of which *A. laricifolia* is included in the American flora.

Sagina occidentalis S. Wats. has been collected in Idaho by Leiberg.

CARYOPHYLLACEAE

WAHLBERGELLA Fries, Bot. Not. 1843: 143. 1843

The treatment of the Silenoid genera of this family has been very different in this country and in Europe. S. Watson and B. L. Robinson admitted only two genera, *Silene* and *Lychnis*, while Pax* admitted beside *Silene* the genera *Lychnis*, *Melandryum*, and *Viscaria*, and Williams† admitted *Lychnis*, *Coronaria*, *Viscaria*, *Eudianthe*, and *Melandrium*. The only distinction given by Watson and Robinson is the number of styles, in *Silene* 3, in *Lychnis* 5, but Robinson admits that in some species of *Silene* the styles are sometimes 4 or 5. The number of styles is therefore not a very reliable character. Continental authors usually differentiate *Silene* from *Melandrium* (by Americans included in *Lychnis*) by the partially septate capsule of the former. According to Robinson this character is unreliable in our American species. Perhaps the species included in *Silene* without septum should be removed to *Melandrium* or to *Eudianthe*. As these doubtful species are not found in the Rockies, I shall give no opinion on them here. It is evident that the genus *Lychnis* as treated in America is an unnatural and composite group. Williams' treatment is perhaps the most logical. Pax included our native American species of *Lychnis* in *Melandrium* but divided the genus in three subgenera. One of these subgenera corresponds to *Eudianthe* with only 3 styles. The other two subgenera correspond to the original species of *Melandrium* and the genus *Wahlbergella* of Fries,

* Engl. & Prantl, Nat. Pflanzenf. 3: 1*b*: 70, 73. 1889.
† Jour. Bot. 31: 170, 171. 1893.

respectively. The typical species of *Lychnis* have 5-valved capsules with entire valves. In the typical species of *Melandrium* the valves are 2-cleft at the apex. In *Wahlbergella* the valves are also more or less notched. In that respect the species belong rather to *Melandrium* than to *Lychnis*. But the typical species of *Melandrium* are dioecious plants with ample long-exserted petals and of a different habit from that of our native species. These all have hermaphrodite flowers with very small and inconspicuous or even no petals. In my opinion the genus *Wahlbergella* should be taken up for our native species usually included in *Lychnis*. *Lychnis Drummondii* (Hook.) S. Wats. is somewhat different in habit and fruit and was referred to *Elisanthe* by Ruprecht, but I think it can well be included in *Wahlbergella*. Of course *L. striata* Rydb. is closely related to it and should be referred to the same genus, whatever disposition of it is made. The species of *Wahlbergella* in America are as follows:

Wahlbergella Drummondii (Hook.) Rydb. comb. nov.

Silene Drummondii Hook. Fl. Bor.-Am. **1**: 89. 1830.
Elisanthe Drummondii Rupr. Fl. Cauc. **1**: 200. 1869.
Lychnis Drummondii S. Wats. Bot. King Exp. 37. 1871.

Wahlbergella striata Rydb. comb. nov.

Lychnis striata Rydb. Bull. Torrey Club. **31**: 408. 1904.

WAHLBERGELLA TRIFLORA (Vahl) Fries, Summa Veg. Scand. 155. 1845

Lychnis triflora R. Br. Ross. Voy. App. CXLII (hyponym). 1819.
Melandrium triflorum Vahl, in Liebm. Fl. Dan. **14**[40]: 5. 1843.

Wahlbergella Taylorae (Robinson) Rydb. comb. nov.

Lychnis Taylorae Robinson, Proc. Am. Acad. **28**: 150. 1893.

WAHLBERGELLA AFFINIS (Vahl) Fries, Bot. Not. **1843**: 143. 1843
Lychnis affinis Vahl, in Fries, Nov. Mant. **3**: 36. 1842.
Melandrium affine Vahl, in Liebm. Fl. Dan. **14**[40]: 5. 1843.

Wahlbergella montana (S. Wats.) Rydb. comb. nov.

Lychnis montana S. Wats. Proc. Am. Acad. **12**: 247. 1877.

Wahlbergella Kingii (S. Wats.) Rydb. comb. nov.
Lychnis Kingii S. Wats. Proc. Am. Acad. **12**: 247. 1877.

Wahlbergella attenuata (Farr) Rydb. comb. nov.
Lychnis attenuata Farr, Contr. Bot. Lab. Univ. Pa. **2**: 419. 1904.

Wahlbergella Parryi (S. Wats.) Rydb. comb. nov.
Lychnis Parryi S. Wats. Proc. Am. Acad. **12**: 248. 1877.

WAHLBERGELLA APETALA (L.) Fries, Summa Veg. Scand. 155. 1845
Lychnis apetala L. Sp. Pl. **1**: 437. 1753.
Melandryum apetalum Fenzl; in Ledeb. Fl. Ross. **1**: 326. 1842.
Wahlbergella uniflora Fries, Bot. Not. **1843**: 143. 1843.

RANUNCULACEAE

Ranunculus rivularis sp. nov.

Ranunculus repens S. Wats. Bot. King Exp. 9. 1871.

A perennial with a fascicle of fibrous roots; stem hirsute, producing long stolons sometimes over 1 m. long, rooting at the nodes and there producing plantlets; leaves ternate, 5–15 cm. wide, divisions petiolate, ovate, usually truncate or subcordate at the base, 3-cleft and coarsely toothed; petals rounded-obovate, about 4 mm. long, scarcely equalling the sepals; head of fruit globose; achenes glabrous, beaks about one third their length.

The type was determined as *R. repens* L. by Dr. Watson, but is not so closely related to that species as to *R. Macounii* Britton. It was probably on account of the creeping and rooting habit that it was referred to the former. The small petals should at a glance have revealed the error, for in *R. repens* the petals are large and rounded, much exceeding the sepals. *R. Macounii* is occasionally decumbent but not rooting, and the outline of the leaflets or divisions is different and the beak about one half as long as the body of the achenes. My own specimens from Kimball, Nebraska, had stems over 1 m. long. It grows on wet river banks.

NEVADA: Huntington Valley, August 1868, *S. Watson 27* (type, in herb. Columbia University).

ARIZONA: Clark Valley, August 1883, *Rusby*.

NEBRASKA: Kimball, August 12, 1891, *Rydberg 7*.

TEXAS: 1851, *Wright 839*.

Thalictrum columbianum sp. nov.

A plant resembling *T. venulosum* Trelease in habit; stem 3–5 dm. high; leaves 2–4 times ternate, petioled except the uppermost; leaflets rather crowded, thick, and veiny, 1–2 cm. long, cuneate to nearly orbicular, 3-lobed and deeply toothed; inflorescence narrow; achenes oblong- or ovate-lanceolate, somewhat flattened, 4–5 mm. long, 1.5–2 mm. wide; veins strong, but not corky, and with broad and shallow grooves between.

The western specimens referred to *T. venulosum* by Dr. W. Trelease belong to this species, which differs mainly in the structure of the achenes, these approaching those of *T. megacarpum* Torr.

WASHINGTON: Loomiston, August 1897, *Elmer 599* (type, in herb. N. Y. Bot. Garden); Yakima County, 1892, *Henderson 2376.*

IDAHO: Pend d'Oreille River, 1861, *Lyall;* Lake Waha, July 1896, *A. A. & E. Gertrude Heller 3361;* De Lamar, July 7, 1892, *Miss Mulford.*

OREGON: 1886, *Cusick 1337.*

Delphinium Leonardi sp. nov.

A perennial with a tuberous root; stem 2–5 dm. high, viscid-pubescent, especially above; blades of the basal leaves 4–5 cm. wide, dissected into oblong, obtuse divisions, more or less viscid-pubescent; upper leaves with linear, acute divisions; lower pedicels 4–8 cm. long, ascending; sepals dark blue, oblong, obtuse or the upper acute; spur about 2 cm. long, slightly *s*-curved; upper petals whitish, veined with blue, emarginate; lower petals blue, with short lobes; follicles over 2 cm. long, curved, viscid-pubescent or in age glabrate; seeds dark brown, wing-margined.

It grows on river banks and beaches at an altitude of 1,800–2,400 m. It is related to *D. bicolor* Nutt. but differs in its longer spur, which is half longer than the obtuse instead of acute lateral sepals.

UTAH: Garfield, May 30, 1884, *Leonard 205* (type, in herb. N. Y. Bot. Garden); City Creek Canyon, April 21 and May 17, 1883, *Leonard 32* and *24.*

Delphinium coelestinum sp. nov.

A perennial with a short rootstock and strong woody roots; stem 3–5 dm. high, glabrous or slightly pubescent above, leafy; leaves long-petioled; blades about 3 cm. broad, sparingly pubescent,

divided to the base into 3–5 narrowly cuneate divisions, these again cleft into linear-oblong, obtuse, mucronate lobes; sepals light blue, slightly pubescent outside, oblong, obtusish, about 1 cm. long; spur about 1 cm. long, usually somewhat curved; upper petals 8 mm. long, yellowish white, slightly lobed; lower petals light blue, with obtusish, wavy lobes; follicles 8–10 mm. long, slightly puberulent, nearly straight.

This species is related to *D. scaposum* but differs in its more leafy stem and in the more deeply dissected basal leaves with narrower segments. It grows in arid places.

UTAH: Southern Utah, 1877, *Palmer 11* (type, in herb. Columbia University).

ARIZONA: 1876, *Palmer 3*.

Delphinium xylorrhizum sp. nov.

A perennial with a stout woody root, related to *D. scaposum* but not at all scapiform; stem 2–3 dm. high, glabrous; leaves petioled, glabrous, fleshy; blades of the basal ones divided into 3–5 broadly cuneate divisions, these cleft and lobed with ovate or rounded lobes; stem leaves with linear-oblong lobes; sepals dark blue, oval, obtuse, pubescent outside; spur stout, about 15 mm. long; upper petals yellowish, about 7 mm. long, slightly cleft, with obtuse lobes; lower petals blue, with sinuate, obtuse lobes; follicles canescent-strigose.

This species differs from *D. scaposum* Greene in its leafy stem and its strigose follicles. It grows on clayey hillsides.

MONTANA: Lima, July 1, 1895, *Shear 3429* (type, in herb. N. Y. Bot. Garden).

Delphinium Helleri sp. nov.

A perennial with a short rootstock and fleshy roots; stem about 3 dm. high, viscid-pubescent throughout, few-leaved; leaf blades 3–5 cm. broad; the lower dissected into linear, obtuse divisions, more or less viscid-pubescent; the upper with narrowly linear, acute divisions; flowers few; the lower pedicels 4–6 cm. long, ascending; bractlets subulate, inserted some distance below the calyx; sepals dark blue, more or less pubescent, oval, about 15 mm. long; spur 2–2.5 cm. long, straight and attenuate; upper petals blue, tinged with yellow only on the lower edge, entire or slightly cleft, lower petals blue, with acute, crenate lobes; follicles viscid-pubescent, nearly straight, 2 cm. long.

This is related to *D. bicolor*, but the upper petals are dark blue and the spur is much longer.

IDAHO: Lewiston, April 1896, *A. A. & E. Gertrude Heller 2951* (type, in herb. Columbia University); region of Coeur d'Alene Mountains, June 24, 1895, *Leiberg 1031*.

Delphinium viscidum sp. nov.

Perennial with a woody root; stem about 3 dm. high, grayish strigose below, densely glandular-viscid above; leaf blades 5–7 cm. broad, densely grayish strigose, dissected into narrowly linear lobes; inflorescence branched; sepals dark blue, 12–15 mm. long, oblong, acute; spur 10–12 mm. long, somewhat *s*-curved; upper petals yellowish, tinged with blue, obtuse, entire; lower petals dark blue, with obtuse, sinuate lobes; follicles densely strigose.

This species is related to *D. multiflorum* and *D. reticulatum*, but the leaves are finely dissected as in *D. Geyeri* and *D. scopulorum*.

WYOMING: Near Tie Siding, July 6, 1896, *Osterhout* (type, in herb. N. Y. Bot. Garden); Evanston, August 1878, *Harry Edwards*.

BRASSICACEAE

Lepidium hirsutum nom. nov.

Lepidium intermedium v. *pubescens* Greene, Bot. Gaz. **6**: 157. 1880. Not *L. pubescens* Desv. 1814.

Lepidium medium pubescens Robinson, Syn. Fl. 1[1]: 127. 1895.

Lepidium virginicum subsp. *texanum* v. *pubescens* Thell. Mitt. Univ. Zürich **28**: 230. 1906.

Physaria lanata (A. Nels.) Rydb. comb. nov.

Physaria didymocarpa lanata A. Nels. Bull. Torrey Club **31**: 241. 1904.

This, I think, deserves specific rank, but *P. grandiflora* Blankinship is nothing but the typical *P. didymocarpa*.

Radicula trachycarpa (A. Gray) Rydb. comb. nov.

Nasturtium trachycarpum A. Gray, Bull. U. S. Geol. & Geog. Surv. **2**: 233. 1876.

CHEIRINIA Link, Enum. Hort. Berol. **2**: 170. 1822

The type of the genus *Erysimum* (Tourn.) L. is *E. officinale* L., usually known under the name *Sisymbrium officinale* Scop. If the genus which has usually passed under the name *Erysimum* is regarded as distinct from *Cheiranthus*, it must be known under another name. The oldest available name is *Cheirinia*, with *Erysimum cheiranthoides* as the type. As I regard the Rocky mountain species well distinct generically from the wallflower of Europe, I adopt *Cheirinia* as the name for the genus.

CHEIRINIA CHEIRANTHOIDES (L.) Link, Enum. Hort. Berol. **2**: 170. 1822

Erysimum cheiranthoides L. Sp. Pl. 661. 1753.
Cheiranthus cheiranthoides Heller, Cat. N. Am. Pl. 4. 1898.

Cheirinia syrticola (Sheld.) Rydb. comb. nov.

Erysimum syrticolum Sheld. Bull. Torrey Club **20**: 285. 1893.
Cheiranthus syrticola Greene, Pittonia **3**: 136. 1896.

Cheirinia inconspicua (S. Wats.) Rydb. comb. nov.

Erysimum parviflorum Nutt. in T. & G. Fl. N. Am. **1**: 95. 1838. Not *E. parviflorum* Pers. 1807.
Erysimum asperum inconspicuum S. Wats. Bot. King Exp. 24. 1871.
Erysimum inconspicuum MacMillan, Metasp. Minn. Valley 268. 1892.
Cheiranthus inconspicuus Greene, Pittonia **3**: 134. 1896.

Cheirinia arida (A. Nels.) Rydb. comb. nov.

Cheiranthus aridus A. Nels. Bull. Torrey Club **26**: 351. 1899.

Cheirinia aspera (Nutt.) Rydb. comb. nov.

Cheiranthus asper Nutt. Gen. N. Am. Pl. **2**: 69. 1818.
Erysimum asperum DC. Syst. **2**: 505. 1821.

Cheirinia elata (Nutt.) Rydb. comb. nov.

Erysimum elatum Nutt. in T. & G. Fl. N. Am. **1**: 95. 1838.
Cheiranthus elatus Greene, Pittonia **3**: 135. 1896.

Cheirinia asperrima (Greene) Rydb. comb. nov.

Cheiranthus asperrimus Greene, Pittonia **3**: 133. 1896.

Cheirinia oblanceolata Rydb. comb. nov.

Erysimum oblanceolatum Rydb. Bull. Torrey Club **31**: 557. 1904.

Cheirinia Bakeri (Greene) Rydb. comb. nov.

Cheiranthus aridus Greene, Pittonia **4**: 198. 1900. Not *C. aridus* A. Nels. 1899.

Cheiranthus Bakeri Greene, Pittonia **4**: 235. 1901.

Erysimum Bakeri Rydb. Bull. Torrey Club **33**: 141. 1906.

Cheirinia argillosa (Greene) Rydb. comb. nov.

Cheiranthus argillosus Greene, Pittonia **3**: 136. 1896.

Erysimum argillosum Rydb. Bull. Torrey Club **33**: 141. 1906.

Cheirinia nivalis (Greene) Rydb. comb. nov.

Cheiranthus nivalis Greene, Pittonia **3**: 137. 1896.

Erysimum nivale Rydb. Bull. Torrey Club **31**: 558. 1904.

Cheirinia radicata Rydb. comb. nov.

Erysimum radicatum Rydb. Bull. Torrey Club **31**: 558. 1904.

Cheirinia Wheeleri (Rothr.) Rydb. comb. nov.

Erysimum Wheeleri Rothr. Rep. U. S. Geog. & Geol. Surv. **6**: 64. 1878.

Cheiranthus Wheeleri Greene, Pittonia **3**: 135. 1896.

Erysimum asperum alpestre Cockerell, Bull. Torrey Club **18**: 168. 1891.

Erysimum alpestre Rydb. Bull. Torrey Club **28**: 277. 1901.

Cheirinia amoena (Greene) Rydb. comb. nov.

Cheiranthus nivalis amoenus Greene, Pittonia **3**: 137. 1896.

Erysimum amoenum Rydb. Bull. Torrey Club **33**: 143. 1906.

Cheirinia Pallasii (Pursh) Rydb. comb. nov.

Cheiranthus Pallasii Pursh, Fl. Am. Sept. 436. 1814.

Cheiranthus pygmaeus Adams, Mém. Soc. Nat. Mosc. **5**: 144. 1817.

Hesperis pygmaeus Hook. Fl. Bor.-Am. 1: 60. 1830.
Erysimum pygmaeum J. Gay, Erysim. Nov. 4. 1842.

Cheirinia brachycarpa sp. nov.

Biennial; stem 3–6 dm. high, from a taproot, grayish canescent, somewhat striate; leaves all linear-spatulate or oblanceolate, 5–10 cm. long, sparingly canescent; the lower petioled and often minutely denticulate, the upper ones mostly entire; sepals oblong, about 1 cm. long, yellowish green; petals nearly 2 cm. long; claw long and slender; blades rounded-obovate, about 7 mm. wide, bright yellow; fruiting pedicels about 8 mm. long, strongly ascending; pods erect, 4–6 cm. long, 2.5 mm. thick; beak about 1 mm. long.

This species resembles *C. oblanceolata*, but the pod is much thicker and shorter and the flowers larger. It differs from *C. aspera* in its ascending, not divergent, and shorter pod. It grows on dry hillsides at an altitude of 2,500–3,000 m.

UTAH: Abajo Mountains, August 17–20, 1911, *Rydberg & Garrett 9713* (type, in herb. N. Y. Bot. Garden, flowers and young fruit); *9765* (well-developed fruit); Cottonwood Canyon, June 27 and July 1, 1905, *Rydberg & Carlton 6333* and *6570*.

Sophia leptostylis sp. nov.

Annual; stem 3–6 dm. high, rather simple below, sparingly stellate-pubescent or glabrous; leaves 3–10 cm. long, obovate in outline, twice pinnatifid, with oblong divisions, sparingly stellate-pubescent; the uppermost reduced and with narrower lobes; flowers numerous; sepals elliptic, yellow, 1–1.5 mm. long; petals spatulate, a little surpassing the sepals; pedicels in fruit 5–8 mm. long, spreading-ascending; pods about 5 mm. long, tapering to each end, nearly erect, somewhat curved; styles 0.5–0.7 mm. long; seeds more or less in two rows.

This resembles somewhat *S. procera*, especially in the form of the pods, but the inflorescence is more open and the pedicels more spreading. It grows at an altitude of 2,000–3,000 m.

UTAH: Big Cottonwood Canyon, July 4, 1905, *Rydberg & Carlton 6629* (type, in herb. N. Y. Bot. Garden); also June 29, *6498*, and July 8, *6806;* Big Cottonwood Canyon, June 1905, *Garrett 1361;* near Milford, June 22, 1905, *Rydberg & Carlton 6283;* mountains north of Bullion Creek, near Marysvale, July 23, *Rydberg &*

Carlton 6283; Fish Lake, August 2, 1909, *Garrett 2578;* Elk Mountains, August 8, 1911, *Rydberg & Garrett 9552;* Head of Dry Wash, August 11, 1911, *9628;* Mount Ellen, July 25, 1894, *M. E. Jones 5684g;* Logan Canyon, June 28, 1910, *C. P. Smith 2226.*

Arabis MacDougalii sp. nov.

Perennial; stem 4–6 dm. high, simple below, densely stellate-pubescent; basal leaves narrowly oblanceolate, 2–4 cm. long, entire or denticulate, densely stellate-pubescent; stem leaves linear or linear-lanceolate, sagittate at the base; sepals oblong, stellate-pubescent; petals white, oblanceolate, 5–6 mm. long; pedicels in fruit reflexed, 5–10 mm. long; pods finely stellate-pubescent, reflexed, 4–5 cm. long, 1.5 mm. wide; seeds in one row.

This species is related to *A. subpinnatifida* but differs in its smaller white petals and its entire leaves.

MONTANA: Old Sentinel, near Missoula, June 12, 1901, *MacDougal 191* (type, in herb. N. Y. Bot. Garden).

NEVADA: King Canyon, Ormsby County, June 4, 1902, *C. F. Baker 986* (referred here doubtfully).

Arabis brevisiliqua sp. nov.

Biennial; stems 3–4 dm. high, sparingly stellate-pubescent below, otherwise glabrous; basal leaves narrowly oblanceolate, 1–2 cm. long, finely stellate-pubescent; stem leaves linear, sagittate at the base, glabrous; sepals scarious-margined, 3 mm. long, glabrous or nearly so; petals purplish, about 6 mm. long; pedicels in fruit 3–5 mm. long, recurved pods 2–3 cm. long, 2 mm. wide, glabrous; seeds in two rows.

This species resembles *A. lignifera* A. Nels., but the pod is much shorter, less than 3 cm. long, with the seeds in two rows, and the sepals are glabrous instead of stellate-pubescent.

BRITISH COLUMBIA: Skagit Valley, July 6, 1905, *J. M. Macoun 70825* (type, in herb. N. Y. Bot. Garden); near international boundary, between Kettle and Columbia rivers, July 16, 1902, *J. M. Macoun 63496.*

ALBERTA: Trail to Lake O'Hara, August 8, 1904, *John Macoun 64517* in part.

Parrya platycarpa sp. nov.

Parrya macrocarpa S. Wats. Bot. King Exp. 14. 1871. Not *P. macrocarpa* R. Br. 1821.

Perennial with a stout caudex; leaves basal, runcinate, more or less glandular-hirsutulous, thick, 6–8 cm. long, oblanceolate in outline; scape 1–1.5 dm. long, glandular-hirsutulous; sepals oblong, 8 mm. long, saccate at the base; petals 15–18 mm. long, purplish; claws long, exceeding the sepals; blades obovate; fruiting pedicels 8–15 mm. long, ascending; pod erect, glandular-hispidulous, 3–4 cm. long, 6–7 mm. wide, acute at both ends, slightly constricted between the seeds, these broadly winged, 3–4 mm. wide.

This is characterized by its deeply lobed leaves, the hispidulous pubescence, the broad hispidulous pod, and the longer narrow petals with slender claws.

UTAH: Uintah Mountains, August 1869, *S. Watson 54* (type, in herb. Columbia University); also August 1889 and Aug. 11, 1890, *M. E. Jones.*

Smelowskia lobata sp. nov.

A densely cespitose perennial; earlier basal leaves cuneate or oblanceolate, merely lobed, with oblong divisions or even some of the earliest entire; the rest of the leaves pinnatifid, densely white stellate-floccose; stem 1 dm. high or less; sepals densely villous, 3 mm. long, ovate, acute; petals white, clawed; blades rounded-obovate; pod glabrous, about 5–6 mm. long, oblanceolate, tapering at the base; style very short.

This species has the pubescence of *S. ovata*, but the pod is tapering at the base. It has whiter and longer pubescence than *S. americana*, and the pod is much shorter. It differs from both in the shape of the earlier leaves.

ALBERTA: Northern Rocky Mountains, *Bourgeau*, Palliser Expedition (type, in herb. Columbia University).

MONTANA: Midvale, June 28 and July 9, 1903, *Umbach 206* and *325*.

MACKENZIE: *Richardson* (Franklin's Journey).

Draba pectinata (S. Wats.) Rydb. comb. nov.

Draba glacialis pectinata S. Wats. Proc. Am. Acad. **23**: 260. 1888.

This has been confused with *D. andina* Nutt. and *D. densiflora* Nutt., but it is easily distinguished by the leaves. They are scarcely stellate-pubescent, merely strongly ciliate on the margins and with an incurved tip. In the other two species the leaves

are densely stellate-pubescent and their tips not incurved but spreading. The pods of *D. andina* and *D. pectinata* are nearly the same, but that of *D. densiflora* is larger and more elongated.

Nelson, in the New Manual of the Central Rocky Mountain Region, cited *Draba uber* A. Nels., *D. aureformis* Rydb., and *D. decumbens* Rydb. as synonyms of *D. luteola* Greene. The species he described under that name is evidently *D. aurea* Vahl, of which *D. uber* apparently is a synonym. *D. luteola* and *D. aureformis*, on the contrary, are closely related to *D. surculifera* A. Nels. but have light yellow flowers. A " conservative " botanist would unite the three. *D. decumbens* Rydb. is not closely related to either. Very likely Professor Nelson had not seen a specimen of the last named.

Fortunately, *Draba lapilutea* A. Nels. and *D. yellowstonensis* A. Nels. become synonyms of *D. praealta* Greene. *Draba deflexa* Greene has erroneously become *D. reflexa* in the New Manual.

NEW YORK BOTANICAL GARDEN.

Discoid gemmae in Radula

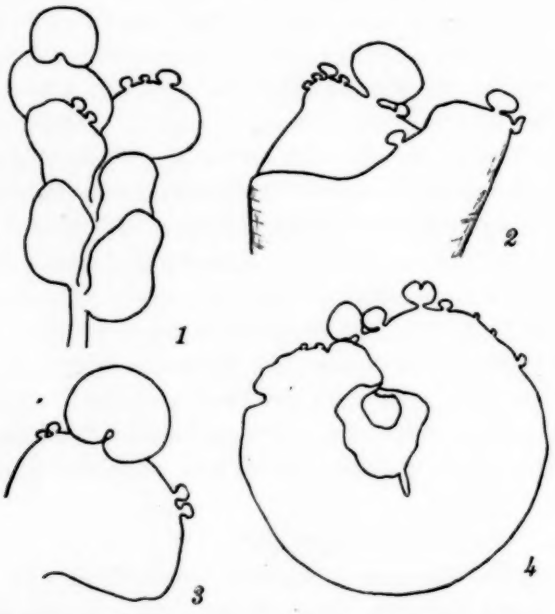
RUTH WILLISTON

Discoid gemmae, borne on the margins or surface of the leaves or on the thallus, have been reported in the following twelve genera of the Jungermanniales: *Metzgeria*, *Radula*, *Porella*, *Metzgeriopsis*, *Colurolejeunea*, *Diplasiolejeunea*, *Cololejeunea*, *Leptocolea*, *Aphanolejeunea*, *Lejeunea*, *Cyclolejeunea*, and *Frullania*. (See Evans, '04, '10, and '11.) It is probable, however, that they occur in others. In *Radula* they are definitely known in only seven species, although the genus, according to Stephani ('10), contains 220 species in all. In two species, *R. Hedingeri* and *R. tjibodensis*, the development of the gemmae has been carefully studied by Goebel ('87). A third species, *R. complanata*, was investigated by Cavers ('03) and later by Stevens ('10). In *R. flaccida* gemmae were observed by Gottsche ('63), in *R. Lindbergiana* by Jack ('81), in *R. protensa* by Schiffner ('93), and in *R. subtropica* by the writer; but no details about the gemmae in these four species have as yet been published. The present paper will be largely devoted to the gemmae of *R. flaccida* and *R. protensa*, although the other species will be included in the discussion.

RADULA FLACCIDA

This species was first described from Mexico in 1847 by Lindenberg and Gottsche (Syn. Hepat. 726). It has since been found widely distributed throughout the West Indies and the lowlands of tropical America. The material used in this study was collected by Dr. A. W. Evans at Bath, Jamaica (no. 332). *R. flaccida* is a dioecious species with a prostrate stem. It is epiphyllous. The gemmae are disklike bodies, one cell thick, attached to the dorsal margins of the leaves. They are the largest and most highly differentiated gemmae known in the genus, averaging at maturity 0.5 mm. in diameter, while the leaves themselves measure only 0.8 mm. in length. The cells nearest the center of the gemmae are the largest, averaging 0.02 mm. in diameter.

Toward the periphery they decrease gradually in size, those at the very edge averaging about 0.01 mm. Gemmae occur in this species on leaves of vegetative branches (FIG. 3), on male bracts (FIG. 1), on the margins of old perianths (FIG. 2), and on other gemmae (FIG. 4). Gemmae occurring on leaves or bracts were most numerous along the acroscopic margins, and in no case were gemmae found on the lobules of the leaves. There is apparently some relation between the stage of development of a vegetative branch and its capacity to produce gemmae, for the gemmae are rarely



FIGURES 1–4, *Radula flaccida*. 1, male bracts and proliferation of antheridial branch bearing gemmae, ×266. 2, old perianth bearing gemmae, ×66. 3, normal vegetative leaf with gemmae, ×266. 4, small gemmae growing on the margin of a mature gemma, ×66.

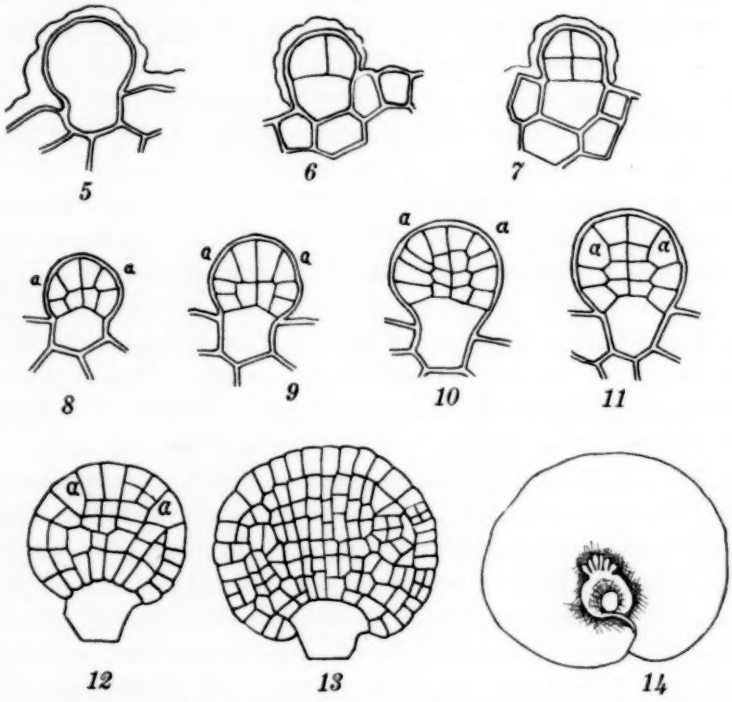
found on young plants. The fact that gemmae are never found on the youngest leaves indicates, however, that their production does not absolutely limit the growth of the shoot. When a branch produces gemmae at all, they generally occur on several of the leaves. A leaf may produce gemmae singly or in groups. In the latter case two or three gemmae are usually found together,

though groups of seven or eight may occur. In instances where more than one are produced on a single leaf, usually only one matures, and the others either become abortive or delay their development until the first one is shed.

In the development of the gemmae the sequence of cell division can be traced accurately only in the earlier stages, as with the increasing complexity of the gemmae the order of cell formation becomes somewhat variable. The formation of a gemma begins by the enlargement of a single marginal cell and its protrusion beyond its neighbors. This cell begins at once to secrete a transparent gelatinous substance. A similar secretion was noted in the early stages of *R. complanata* by Stevens ('10, p. 369), who suggests that the presence of this gelatinous substance may be taken as a rough indication of the region of most rapid growth. As this cell increases in size and pushes farther beyond the margin of the leaf, it takes on a knoblike shape (FIG. 5), and finally the end of the knob is cut off by a wall parallel to the margin of the leaf (FIG. 6). The inner of the two cells thus formed is the stalk cell, the outer the mother cell of the gemma. The stalk cell undergoes no division but increases slightly in size. The outer cell, however, soon divides by a median wall at right angles to the first. Each of the resulting cells then divides by a transverse wall. The original mother cell is now separated into quadrants (FIG. 7). The two outer quadrants are triangular in shape and generally begin at once to function as two-sided apical cells, cutting off segments first on the side toward the median line then on the side toward the lower quadrant, and so on until three or four segments have been formed (FIG. 8, 9, 10, 11, 12). The earlier segments divide first by periclinal walls and later by anticlinal walls, so that by the time the last segment is cut off by the apical cell the first may have divided into as many as six or eight cells. The apical cells both cease to function after a short time; and instead of cutting off segments in the normal way each divides by a periclinal wall followed by an anticlinal wall in the peripheral cell, thus giving rise to three cells.

The establishment of the apical cells is not always simultaneous on the two sides of a single gemma. The original triangular quadrant on one side or both may cut off an extra cell parallel

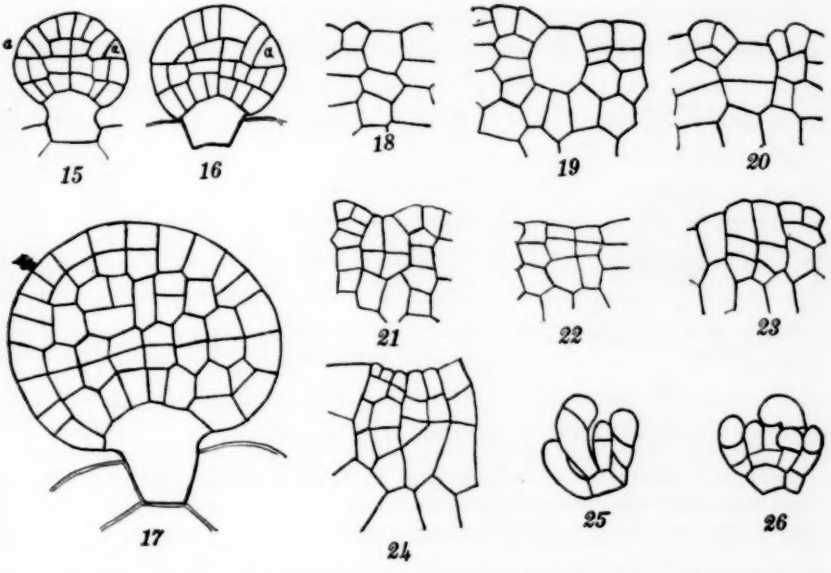
to the median wall before the apical cell becomes established. In case the two apical cells of a single gemma behave differently, there is an asymmetrical development of the gemma. If one apical cell becomes established before the other, it usually but not always ceases to function before the other; so that it is common to find a gemma with one apical cell cutting off a segment in the normal way while the other has already divided by a periclinal



FIGURES 5–14. *Radula flaccida.* Gemmae in various stages of development from single cell stage to the mature form. 5–7 show the gelatinous substance *m* and early divisions, ×400. 8–12 show the apical cells *a*, ×400. 14, mature gemma with funnellike elevation and basal cells, ×66.

wall (FIG. 17). The same condition was observed in *R. complanata* by Stevens ('10, p. 370). This irregularity in the manner of establishment of the apical cell makes it possible to distinguish three types of gemmae: those in which the original apical quadrants begin immediately to function as apical cells (FIG. 9, 10, 11), those in which the apical quadrants cut off cells parallel with the

median wall before beginning to function as apical cells (FIG. 15), and those in which the establishment of the two apical cells is not simultaneous (FIG. 16). In any case the shape and size of the two sides of the gemma are not noticeably affected (FIG. 16 and 17), The two lower quadrants of the gemma mother cell do not produce apical cells but divide by longitudinal walls followed by transverse walls. After the apical cells in the upper half of the gemma cease to function, the whole gemma increases in size by the same method of cell division, followed by the inner or lower half from

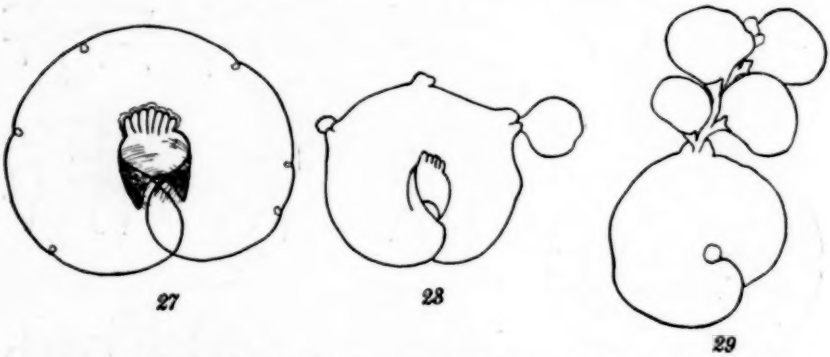


FIGURES 15–26, *Radula flaccida*. Gemmae with irregularities in the formation of the apical cells. 15, gemma which has cut off a segment on each side toward the median line before the apical cell has begun to function, ×400. 16, gemma in which the development of the two apical cells is not simultaneous, ×400. The apical cell on the left was formed from the original triangular quadrant, cut off one segment toward the median line, and ceased to function. The apical cell on the right was formed from the outer half of the original triangular quadrant and is still functioning. 17, gemma in which the apical cell on the left has ceased to function, while that on the right is still cutting off segments, ×533. 18 and 19 show the method of the development of the marginal cell, which later produces the leafy shoot, ×400. 20–22, stages in development of the leafy shoot from a single marginal cell, ×400. 23 shows a variation in the sequence of cell division, ×400. 24, dorsal view of later stage in development of the leafy shoot, ×533. 25 and 26 show the leafy shoot, ventral view, developing in dextrorse and sinistrorse spirals, ×800.

the beginning, each cell dividing by longitudinal walls followed by transverse walls; but as the gemma grows older the order of cell division is reversed, and the transverse walls are formed first and the longitudinal later.

In *R. Hedingeri* Goebel reports ('87, p. 52) that there are no apical cells whatever, and the gemma mother cell divides by a series of longitudinal walls between which transverse walls are formed.

Soon after the apical cells cease to function, the gemma begins to change its position and shape. Up to this time it has been a flat circular body protruding by the stalk cell beyond the margin of the leaf. Now the six or eight basal cells which attach the



FIGURES 27–29, *Radula flaccida*. 27, gemma at maturity, ventral view, showing the large marginal cells and the basal cells, ×66. 28, germinating gemma showing one leafy shoot more advanced than the others, ×266. 29, germinating gemma, later stage, with a well-developed leafy shoot, ×266.

gemma to the stalk begin to grow, especially in length, and curve upwards so that they stand at right angles to the leaf. As this change in position takes place the cells adjacent to the large basal cells begin to divide and grow very rapidly, and to curve outward in such a way that the gemma again becomes parallel with the leaf surface but raised above it by a funnel-shaped tube. A short time before the gemma is mature several large cells become differentiated at intervals along the margin (FIG. 27). These vary in number from three to eight, but there are usually five. Each one arises through the enlargement of one of the peripheral cells, while the adjoining peripheral cells divide by periclinal walls

(FIG. 18 and 19). If the growth and division of the neighboring cells are very rapid, the large cell may appear in a temporary depression, but it soon increases in size so that the mature gemma shows no marginal indentations (FIG. 27).

After the large cells are fully differentiated, the gemma is shed. Shedding takes place by means of a splitting between the stalk cell and the long basal cells (FIG. 16). This splitting is probably caused by a gelatinization of the walls in this region. The stalk cell does not come off with the gemma, as it does in *R. complanata*, but remains a part of the leaf, as in the two species studied by Goebel ('87, *f. 61*). Cell divisions are now at an end until germination takes place, but the gemma may increase slightly in size by the enlargement of its individual cells. When mature it is a slightly concave disk with a funnellike outgrowth near the center and with the six large basal cells often adhering to the edge of the funnel.

All the germinating gemmae in this material were found on the lower surface of the leaves on which the plants were growing. It seemed remarkable that the spaces on the upper surface of the leaves were entirely free from isolated gemmae or young plants. After a gemma comes to rest with its concave side down, the first step in germination is the formation of rhizoids to anchor the young plant. These are developed from the cells near the periphery where the tissue comes in contact with the substratum. The rhizoids consist of short prolongations of the cells, with irregular lobes at the apex. According to Goebel ('87, p. 53, *f. 66*) the similar rhizoids in *R. Hedingeri* probably secrete a gelatinous substance by means of which they adhere to the substratum.

When the gemma is firmly anchored, the five large peripheral cells (FIG. 19) begin to divide (FIG. 20–23). The first wall is always periclinal, and the inner cell thus formed gives rise to the young shoot. The outer cell, as well as the neighboring cells, proceeds to divide and form a tissue which protrudes beyond the margin of the gemma (FIG. 20). This thalluslike body protects the tiny shoot coming out on the ventral side of the concave gemma. The sequence of divisions in the inner cell of the original peripheral cell is very complicated and difficult to follow; but a tetrahedral apical cell is soon formed, the divisions of which cor-

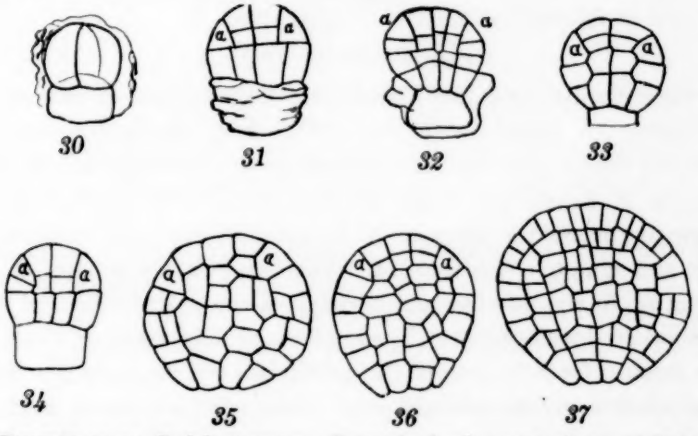
respond to those described by Leitgeb ('79) for the vegetative shoots of *R. complanata*, the cell cutting off segments on three sides only. The fourth face, which does not cut off segments, is the free one of the apical cell and lies toward the apex of the branch. Each segment cut off by a lateral face divides into two cells, an external cell and an internal cell. The external cell gives rise to the two lobes of the leaf and the cortical cells of the stem, while the internal cell by further division forms the axial cells of the stem. The segments cut off by the ventral face never form leaves but give rise to cells of the stem only. The three faces of the apical cell cut off their segments in spiral sequence, but the spiral may be either dextrorse or sinistrorse (FIG. 25 and 26).

RADULA PROTENSA

Lindenberg first described *R. protensa* from Java in 1848 (Meissner, p. 462). It is a tropical species native to Asia and various islands of the Pacific. The material used in this study was collected by Lamberto Loria in New Guinea (no. 114). *R. protensa* agrees with *R. flaccida* in being epiphyllous and prostrate. The gemmae are smaller than in *R. flaccida*, averaging only 0.2 mm. in diameter at time of shedding. It is possible, however, that the gemmae examined had not attained their full size, in spite of the fact that cell division had apparently ceased. In this species gemmae occur on vegetative branches and on male bracts. Schiffner ('93, p. 249) reports them also on the margins of old perianths. They are most commonly found scattered over the ventral surface of the leaves or along the margins and stand at right angles to the surface. They usually appear in groups, a single leaf sometimes bearing fifty or more in various stages of development.

As in *R. flaccida* the development of the gemma begins by the protrusion of an ordinary leaf cell. This cell, however, unlike that of *R. flaccida*, may occur in the surface of the leaf or in the margin. It also becomes covered with a much heavier covering of gelatinous material than is found in *R. flaccida*. The outer half of the cell is then cut off by a transverse wall. This division forms the stalk cell, which does not project beyond the surface of the leaf, and the gemma mother cell, which soon divides into

quadrants. The early walls are very delicate and scarcely show through the surrounding gelatinous layer. As the gemma increases in size it breaks through this sheath, which remains clinging to the base like a collar (FIG. 30). In the further development of the gemma the two apical quadrants function for a time as two-sided apical cells. As described for *R. flaccida*, the stage at which the apical cell becomes established and the stage at which it ceases to function vary. There is no curving or change in position in this gemma as is noted in *R. flaccida;* and at the time of shedding, the gemma is a circular body, one cell thick, slightly concave, but without any funnel-shaped outgrowth similar to that of *R. flaccida*



FIGURES 30–37. *Radula protensa.* Stages in development of gemma from the two-celled stage until the apical cell ceases to function, ×400. 30–32 show the stalk cell and the gelatinous sheath.

(FIG. 14). Shedding takes place by means of a splitting of the wall between the stalk cell and the basal cells. The stalk cell remains as a part of the leaf. The form of the gemma when shed is almost identical with that of the mature gemma of *R. Hedingeri*. Soon after shedding, the basal cells begin to elongate. On account of lack of germinating material it was impossible to trace the further development of the gemma. However, a few gemmae were found in which the marginal cells halfway between the basal cells and the apex, on one side or the other, were dividing and growing, apparently beginning to form a thalluslike outgrowth. So far as could be determined, there were no enlarged cells functioning as

differentiated peripheral growing points, and no gemmae were found in which the leafy shoot had begun to appear. Several young plants showed thalloid fragments clinging to them, but it was impossible to determine in any of these cases whether the fragment was a part of the gemma itself, as in *R. flaccida*, or part of a thallus such as is formed in *R. Hedingeri*.

RADULA LINDBERGIANA AND RADULA SUBTROPICA

R. Lindbergiana, a species native to Europe, Asia, and Algeria, first described by Gottsche in 1864, and *R. subtropica*, native to Brazil, and described by Stephani in 1910, were also studied. In these the gemmae were essentially the same as those of *R. complanata* as figured by Stevens ('10, p. 370).

COMPARISON OF SPECIES

Gemmae in the genus *Radula* may be arranged in two groups according to their complexity. The first group contains the simplest types and has representatives in three species, *R. complanata*, *R. Lindbergiana*, and *R. subtropica*. The gemmae in this group occur on the margins of leaves and are very irregular in size and shape when mature. This irregularity is due to the variation in the number and activity of the apical cells and their method of development. These gemmae may be more than one cell thick. Germination in this group has not yet been described. The second group contains the more complex types and has representatives in four species, *R. protensa*, *R. Hedingeri*, *R. tjibodensis*, and *R. flaccida*. These gemmae occur not only on the margins but also on the surface of leaves and follow a more regular course of development, the mature gemmae in a given species being uniform in shape and size. In *R. flaccida* and *R. protensa* apical cells are present, but *R. Hedingeri* and *R. tjibodensis*, while developing after a fixed plan, do not, according to Goebel ('87, p. 62), possess any apical cells. All the gemmae belonging to this group are only one cell thick. Germination in this group may be divided into two categories. In the gemmae of *R. Hedingeri*, and *R. tjibodensis*, as described by Goebel, the procedure is as follows: The circular gemma develops at some point on the margin a thalluslike body as large as the gemma itself. One of the marginal cells of this thalloid outgrowth in turn gives rise to the leafy shoot, but by the continued growth of the tissue adjoining

this marginal cell the shoot later appears to arise from the central part of the thallus. The second type of procedure is seen in the germinating gemmae of *R. flaccida*. In this species from five to eight differentiated peripheral growing points immediately give rise to the apical cell of the shoot. The formation of a thallus-like body preliminary to this stage seems to be suppressed. The growth of the outer peripheral cell and its adjoining cells in *R. flaccida* to form a thallus, corresponds to the growth of the thallus in *R. Hedingeri* after the differentiation of the apical cell of the shoot. *R. protensa* probably belongs to the first category and germinates according to the procedure followed by R. *Hedingeri*.

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Notes on the genus Widdringtonites

EDWARD W. BERRY

(WITH PLATES 24, 25)

It is the fashion among a large proportion of botanical students either to ignore or actually to deride botanical determinations based upon the remains of the foliage of fossil plants. While this is perhaps justified in some instances by the sanguine determinations of some paleobotanists, particularly those who might with propriety be referred to as the "fathers" of this as yet young science (such men as Unger, Heer, and Ettingshausen), the real importance of their work is generally underestimated.

The careful description and illustration of a fossil flora is of immense importance even if seventy-five per cent of the identifications are wrong, and for the following reasons: For the purpose of correlating distant geological formations fossils are theoretically almost as useful unnamed as named, or at least they would be if there were some medium for intellectual exchange that did not require names.

To illustrate their value to the botanist I will take the case of A who describes the flora of the Cretaceous or Tertiary of Bohemia, misidentifying half of his species. B studies the Cretaceous or Tertiary flora of Greenland and finds a number of specimens like A's types. Several of B's specimens are better preserved, or are represented by more material, or have attached fruits or seeds, thus enabling B to correct some of A's wrong determinations. C studies the Cretaceous or Tertiary flora of America or Asia and in a like manner corrects or substantiates beyond cavil some of A's or B's determinations. Thus in time we come to know A's original flora and are enabled to make many deductions regarding phylogeny, climate, and distribution, which would be entirely impossible if A had waited until he had his species represented by flowers, fruits, and seeds, which would probably have been never.

I have assumed that foliage remains are not capable of un-

equivocal identification but this is far from being the case in most instances. I did not start, however, to write a plea for paleobotanists, but with the purpose of describing some rather exceptional coniferous material from the Upper Cretaceous of this country, which serves to substantiate a generic determination made years ago by that most sagacious and illustrious of paleobotanists, the late Professor Oswald Heer.

The genus *Widdringtonites* was established in 1847 by Endlicher* with *Thuites gramineus* Sternberg from the Tertiary of Perutz, Bohemia, as the type. This he named *Widdringtonites Ungeri*, including in its synonymy *Juniperites baccifera* Unger, *Thuia graminea* Brongniart, and *Muscites Stolzii* Sternberg. Three additional species were listed, one from the Cretaceous, one from the Wealden, and one from the Lias. His characterization of the genus was as follows: "Folia spiraliter inserta, pleraque squamaeformia adpressa. Strobilus globosus, valvatus."

There are perhaps a score of species, ranging in age from the Triassic to the Miocene, that are referred to this genus at the present time. It has been commonly used for foliar specimens that resembled the living forms but lacked the certainty furnished by associated cones. These are known, however, in a large number of species, many of which, especially those of Tertiary age, are now often referred directly to the genus *Widdringtonia*.

Named originally for its resemblance to the living species of *Widdringtonia* of southern Africa and Madagascar, it is to be noted that in the latest treatment of the modern Cupressineae, by Eichler in Engler and Prantl's Die Natürlichen Pflanzenfamilien (1889), *Widdringtonia* is made a subgenus of *Callitris* Ventenat, the latter being divided into four subgenera as follows: *Octoclinis* F. v. Müller (*Frenela* Bentham) with eight scales to the cone and a single species inhabiting Australia; *Hexaclinis* (*Frenela* Mirbel) with six scales to the cone, 3 large and 3 small, and nine species of Australia and New Caledonia; *Pachylepis* Brongniart (*Widdringtonia* Endlicher) with thick woody cones of four subequal scales and having three or four species of South Africa and Madagascar; *Eucallitris* Brongniart (*Tetraclinis*) with four scales to the cone and a single species of northern Africa.

* Endlicher, Synopsis Coniferarum 271. 1847.

However admirable this arrangement may be when only the living species are considered, it will not answer for the fossil forms, and paleobotanists quite rightly maintain the various genera *Frenelites*, *Frenelopsis*, *Widdringtonia*, *Widdringtonites*, *Callitris*, etc., ranging in age from the older Mesozoic through the Tertiary and abundantly fortified by fruiting specimens. Fossil fruits of still other species and perhaps genera occur in the late Tertiary formations of Australia, the weight of the evidence showing that this type was considerably more varied in the past, the existing

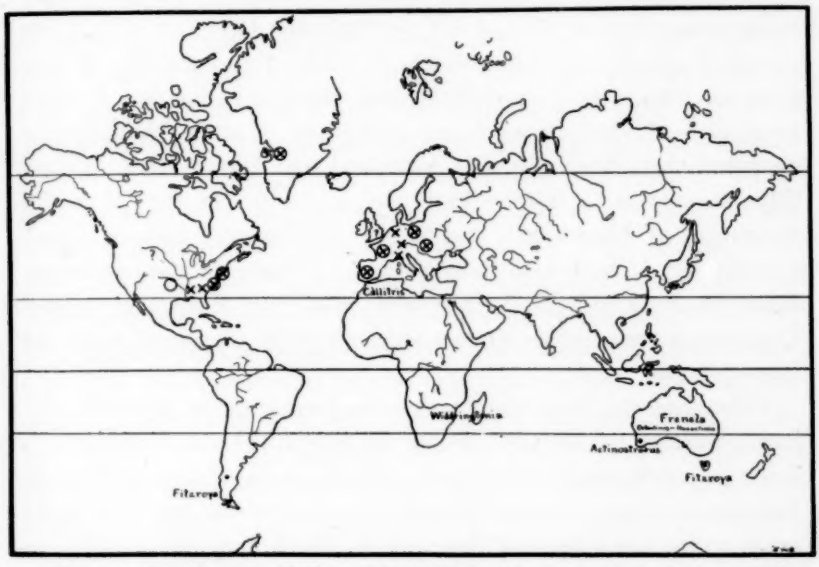

FIG. 1. Sketch map of the world showing the segregation of the existing Actinostrobinæ and the Mesozoic occurrences of *Frenelopsis* and *Widdringtonites*. Circles indicate *Frenelopsis* and crosses indicate *Widdringtonites*.

forms being isolated remnants of a once almost worldwide distribution.

The accompanying sketch map of the world partially indicates the former wide range of these forms. It is incomplete in that it shows only the reported occurrences during the Mesozoic age and does not include the numerous Cenozoic records. It will be seen that *Widdringtonites* is recorded in North America from western Greenland southward to Alabama and *Frenelopsis* from Greenland to Texas. Abroad both types occur abundantly in

central and western Europe. Like so many other types of plants which were widespread in Mesozoic time, they became more and more restricted in their range during the Tertiary, until today they are not found at all in the western hemisphere and are confined to the limited areas indicated on the accompanying sketch map (FIG. 1).

If we refer only to the Cretaceous forms of *Widdringtonites* there are four species in the Neocomian, one in the Barremian, one in the Albian, three in the Cenomanian, and one in the Senonian.

Widdringtonites subtilis was described from the Atane (Upper Cretaceous) beds of Greenland by Professor Heer* in 1874. His material was, however, extremely limited. Subsequently, similar remains were found in considerable abundance in the Raritan formation of New Jersey,† and still more recently Hollick‡ has recorded them from Marthas Vineyard and Block Island (Magothy formation). The writer has found it in the Magothy formation of Maryland§ and in the Middendorf beds of South Carolina.‖ It may also be questioned if some of the coniferous material described by Velenovsky from the Bohemian Upper Cretaceous under other names should not be compared with the present form.

The material from the Tuscaloosa formation of western Alabama, which furnishes the basis for the following notes, is abundant, being especially common at the locality known as the Snow Place in Tuscaloosa County; and it enables a considerable addition to be made to the knowledge of this species, which may be described as follows:

Foliage more or less dimorphic, very variable in this respect. Leaves, especially those on the young twigs, arranged in a crowded spiral, small and pointed; the inner surface comparatively flat and bounded laterally by sharp, somewhat thickened angular edges, the outer side broad, full, and rounded. The young leaves are crowded and relatively short, broad, and appressed, the short incurved pointed tips giving them the appearance of being rounded

* Heer, Fl. Foss. Arctica **3**[2]: 101. *pl. 28. f. 1, b.* 1874.
† Newberry, Fl. Amboy Clays 57. *pl. 10. f. 2–4.* 1896.
‡ Hollick, Mon. U. S. Geol. Surv. **50**: 45. *pl. 4. f. 2–5.* 1907.
§ Berry, Johns Hopkins Univ. Circ. New series 7: 81. 1907.
‖ Berry, Bull. Torrey Club **38**: 421. 1911.

apically (see FIG. 1 and 2). These leaves are not so short and broad as they appear in FIG. 1, 3, 4, 5, since in these specimens the entire leaf substance, except the cuticularized epidermis, has disappeared, and they are much flattened. The older leaves usually become elongated proximad and somewhat spreading and falcate distad, with a considerable decurrent base as shown in FIG. 2. The leaves on twigs of the year are about 1.5 mm. in length while those on old twigs are about 2 to 3 mm. in length. Along their lateral angles the former bear minute spines, which increase in size and length distad (FIG. 3, 3*a*). The epidermal cells are small, about 0.025 to 0.0333 mm. in diameter, the longest diameter approximately parallel with the axis of the leaf, more or less regularly rectangular in outline except at the angles of the leaf and in the vicinity of the stomata, and they have very thick yellowish walls. The stomata are about 0.0333 mm. in diameter and show two thick, generally almost closed, nearly white, blunt-ended guard cells, without fixed orientation with respect to the different pairs or the major axis of the leaf. They appear to lie just beneath the surface of the epidermis. The guard cells are surrounded by a ring of five or six accessory epidermal cells, which are smaller than the regular epidermal cells, nearly uniform in size, and with their inner walls thinner than their outer. These appear to be on the same level as the ordinary epidermal cells. The stomata are sparsely scattered over the major portion of the leaf but are usually absent or but sparingly represented in the distal half of the leaf. They are somewhat massed toward the base on the sides of the leaf.

The position of the stomata on the leaf shown in FIG. 5 is indicated in the enlarged drawing which forms FIG. 5*a*. The degree of spreading or appression of the leaves varies from specimen to specimen, due, I suppose, in some measure to the conditions attending fossilization. A form with uniformly slender and spreading leaves is common at Shirley's Mill, Fayette County, Alabama.

In his discussion of this species Professor Newberry mentions a vague cone about one cm. in diameter as included in the Raritan material from New Jersey. I have not seen this specimen, but I have found a number of poorly preserved detached cones among

the abundant remains of this species in the Upper Cretaceous beds of South Carolina. A number of specimens from the Tuscaloosa formation have these cones attached to the characteristic twigs of this species (PLATE 24, FIG. 2). These cones are terminal, roughly spheroidal in outline, and apparently consist of four thick scales with wide blunt tips and somewhat extended bases. They are 7 to 9 mm. in length and 4 or 5 mm. in diameter and are closely comparable to the cones from the Cretaceous of eastern Europe ascribed to *Widdringtonites Reichii* by both Velenovsky* and Krasser.† One of the best preserved of these attached cones from Alabama is shown enlarged ten times in FIG. 2*a*.

So far as I know, the only previous description of stomatal or epidermal characters in fossil species of the genus *Widdringtonites* refers to species preserved in the Baltic amber, which is of Tertiary age and some millions of years younger than the species just described. One of these species, *Widdringtonites oblongifolius* Goeppert and Menge, is extremely close to the Cretaceous species *Widdringtonites subtilis* Heer not only in its general facies but in the details of its epidermal characters. As described recently by Caspary,‡ the chief difference is the more elongated leaf bases, a feature that is always of extreme variability in this genus, and even within the limits of a single species, as is well shown by the specimens of *Widdringtonites subtilis*, which are figured in the present connection.

Although so little has been published that refers to *Widdringtonites*, several authors have described the somewhat similar epidermal characters in the allied extinct genus *Frenelopsis*. Thus Zeiller§ described these features for the type of the latter genus, *Frenelopsis Hoheneggeri* Schenk, in 1882, and Velenovsky‖ described the very similar *Frenelopsis bohemica* in 1888. Recently the present writer described¶ these features in *Frenelopsis ramo-*

* Velenovsky, Gym. Böhm. Kreidef. 27. *pl. 8. f. 4–6; pl. 10. f. 1, 11, 12.* 1885; Sitz. K. Böhm. Gesell. Wiss. **1886**: 639 (6). *pl. 1. f. 14–16.* 1887.

† Krasser, Beitr. Paläont. Ost.-Ung. u. Orients **10**: 126. *pl. 14 (4) f. 6; pl. 17 (7). f. 4, 7, 8.* 1896.

‡ Caspary, R. Abh. K. Preuss. Geol. Landesanstalt. Neue Folge, Heft 4. **1906**: 66. *pl. 9. f. 52–53c* (see especially *f. 53a, b, c*).

§ Zeiller, Ann. Sci. Nat. Bot. VI. **13**: 231. *pl. 11.* 1882; Elements de Paleobotanique 274. *fig. 196.* 1900.

‖ Velenovsky, Sitz. K. Böhm. Gesell. Wiss. **1888**: 590. *f. 1–3, 10.* 1888.

¶ Berry, Bot. Gaz. **50**: 305–309. *f. 1, 2.* 1910.

sissima Fontaine, a Lower Cretaceous species of eastern North America.

In all of these three species the epidermal cells are small, more or less rectangular, and thick-walled, as they are in *Widdringtonites subtilis*. The stomata consist of a ring of from four to six radially arranged and more or less elevated guard cells. These cells are represented in *Widdringtonites subtilis* by the ring of accessory epidermal cells shown in FIG. 6, which occupy the same level as the rest of the epidermis, while lying below this level are the two stout guard cells.

Frenelopsis ramosissima differs from the other two species of *Frenelopsis* previously mentioned in having certain of the epidermal cells spined, and *Widdringtonites subtilis* Heer curiously resembles *Frenelopsis ramosissima* in that the epidermal cells along the lateral angles of the leaf have more or less developed small spines, which increase in length and size distad, as shown in FIG. 3*a* and 5*a*.

A consideration of the sum of the known characters in the genera *Widdringtonites* and *Frenelopsis* leads to the conclusion that they are surely related.

The combination of similar foliage, similar four-valved cones; and similar epidermal and stomatal features in *Widdringtonites* and *Widdringtonia* render certain the reference of the Upper Cretaceous species *Widdringtonites subtilis* Heer to what represented the modern subfamily Cupressineae during the Cretaceous.

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Explanation of plates 24, 25

PLATE 24

FIG. 1. From a photograph of a specimen from the Tuscaloosa formation at Big Gully, Snow Place, Tuscaloosa County, Ala., natural size.

FIG. 2. Another specimen from the same horizon and locality, showing a number of poorly preserved attached cones.

FIG. 2*a*. One of the cones from the specimen shown in FIG. 2, enlarged ten times.

PLATE 25

FIG. 1. From a photograph of a small terminal twig which was much flattened during fossilization, enlarged five times.

FIG. 2. Drawing of a twig showing the dimorphic character due to the elongation of the leaves on the older twigs, enlarged five times.

FIG. 3. Microphotograph of a leaf showing the indistinct outlines of the epidermal cells and the spinous character of the distal margins, enlarged ten times.

FIG. 3*a*. Drawing of the distal part of the preceding specimen showing the spines, enlarged 50 times.

FIG. 4, 5. Microphotographs of two additional leaves, enlarged ten times.

FIG. 5*a*. Drawing in outline of the specimen shown in FIG. 5, to show the location of the stomata, enlarged 50 times.

FIG. 6. Drawing of one of the stomata and the adjacent epidermal cells, enlarged 205 times.

FIG. 7, 8. Drawing to show the character of the epidermal cells, enlarged 205 times.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1908-1912)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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